# DESCRIPTION AND CONSERVATION OF A PROBABLE MOA'S EGG (AVES: DINORNITHIFORMES)

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*Abstract.* A large, undocumented fossil egg in the Auckland Museum collection was associated with sediment that was probably from the eastern South Island, New Zealand. It is presumed to be a moa's egg (Dinornithiformes), one of only 19 intact enough for measurement of length and width. With external dimensions of approximately 208 x 134 mm the egg would have belonged to one of the medium- to large-sized species of moas. It is a thick-shelled egg (shell at least 1.5 mm thick) with slit-like pores on the outer surface. The conservation treatment involved removing most of the compacted sediment from inside the egg to reduce the risk of damage from excessive weight, and to expose embedded eggshell fragments.

KEYWORDS: Bird; ratite; Dinornithiformes; eggshell; New Zealand; conservation treatment.

## INTRODUCTION

The bird collection at Auckland Museum, New Zealand, contains a large oval-shaped egg, registered B4016 (Figs 1-3). It is shattered into large fragments, with a large section collapsed, but the fragments are held together by fine-grained sediment inside the egg. This egg was present in the collection, unregistered and undocumented, when BJG joined the staff of the museum in 1982. It presumably belonged to one of the species of moas (Order Dinornithiformes), the large extinct ratite birds of New Zealand.

Scattered moa eggshell fragments are common fossils in New Zealand, but whole eggs are exceedingly rare and we decided to assess B4016 for conservation treatment. Only 18 other whole or substantially intact moa eggs are known (see table 1 of Gill 2000).

Sediment had been removed from much of the outer surface of the egg before 1982, exposing most of the shell (Fig. 1), but the interior remained filled with sediment, from the surface of which some shell fragments protruded. An unknown consolidant appeared to have been applied (before 1982) to most of the exposed surface of the sediment. The sediment was likely to be obscuring fragments that had collapsed into the egg. It also made the object too heavy for its fragility and therefore prone to breakage. Removal of sediment therefore seemed desirable, to uncover any hidden fragments, lighten the egg, and make it more interesting for display.

## METHODS

In 1987 a small sample of sediment was sent to the New Zealand Geological Survey for petrographic analysis. In 2000 the egg was subjected to C.T. scanning at the Mercy Hospital, Auckland, to discover what lay buried in the sediment filling the egg's interior. The egg was scanned in slices 8 mm apart to generate two series of images showing the egg in sagittal and

Fig. 1. Presumed moa egg (B4016), blunter end to left, showing the less weathered "lower" surface. Before the present study, sediment had already been cleared from the area above the faint line that runs the length of the egg. Photo: S. Brookbanks.

transverse sections. The C.T. images showed that some large fragments of eggshell were buried inside the egg (Fig. 2), suggesting that what had been evident as a large hole in the side of the egg had formed by the collapse of fragments to the interior.

The conservation treatment was conducted by SC. Using the scanned images as reference, most of the sediment from inside the egg was carefully removed, starting from the centre of the area of exposed sediment. The thin previously-consolidated outer surface of the sediment, and much of the looser sediment beneath, was easily removed with metal dental tools and a dental aspirator. A soft brush was used when close to embedded fragments. A layer of sediment 10-15 mm thick was retained inside the egg to hold the outer fragments in place (Fig. 3). A sample of sediment was kept for future reference. The embedded fragments, once exposed, were found to be as weathered as the main shell. We had hoped that these would be unweathered, and allow accurate measurement of shell thickness. Since there was no advantage in removing them, they were left *in situ* (Fig. 3).

A few small, extremely thin pieces of shell became detached, or crumbled into tiny fragments, during the removal of sediment. The larger shards (c. 3 x 1 mm) were adhered in place using

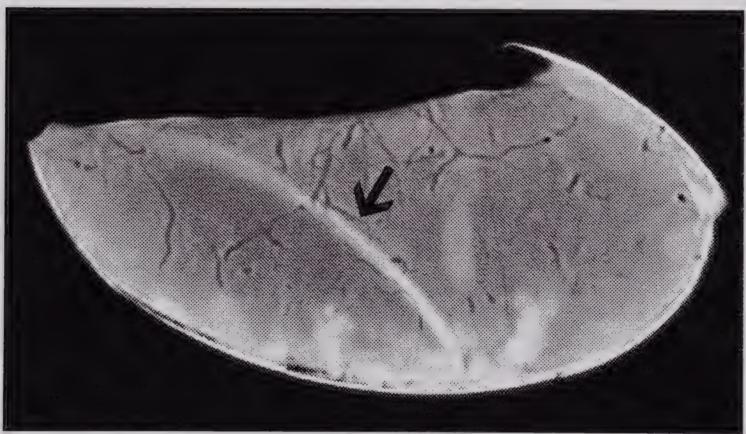

Fig. 2. C.T. scan of presumed moa egg (B4016) in sagittal plane; blunter end to left. A large fragment of shell (arrowed), viewed edge-on, lies embedded in the sediment that fills the egg. The dark, branching lines are possibly cavities left by the roots of plants. Where the sediment was removed right of the collapsed eggshell fragment, the pale, globular shadows proved to be of no consequence. Image: M. Osborne.


Fig. 3. Presumed moa egg (B4016) after conservation treatment, blunter end to left, showing the fragments inside the egg exposed by removal of sediment. Note the weathering of the outer shell surface, and the layer of sediment left inside the egg to hold it together. Photo: S. Cooper.

5% w/v Paraloid B72 acrylic resin in acetone or toluene. Minute pieces which were impossible to relocate were retained in polypropylene bags. Cracked fragments of shell, still attached to the main shell, were adhered in place with 20% w/v Paraloid B72 in acetone. A heated spatula was used at various temperatures to re-adhere a delaminated flap of consolidant film (from previous treatment) on the outside of the egg. After several unsuccessful attempts, it was adhered using 5% w/v Paraloid B72 in acetone.

A small section of sediment against the inside wall of the egg was friable, and was consolidated with 2% w/v methyl cellulose in distilled water. Two areas of excess sediment on the outer surface of the shell were removed mechanically with a scalpel after softening with distilled water. Hardened residues were removed by swabbing with a non-ionic detergent (1% v/v Synperonic N in distilled water) rinsed with distilled water.

A special storage box for the egg was constructed from archival-quality materials.

## RESULTS

### PETROGRAPHIC ANALYSIS

W.A. Watters (pers. comm. 1987) commented as follows on the sample of sediment that he examined:

> The sediment is fairly well sorted and ranges mainly between silt and fine sand, although a small number of relatively coarse grains (up to 0.5 mm across) are also present. It is thus too coarse-grained to be termed a loess; moreover, it is not as well sorted as typical loess. I would say that it had probably been deposited by water, but because of the absence of clay it may have been winnowed by wind action to some extent. The main mineral grains present are quartz, feldspar, chlorite, epidote, minor biotite, and accessory actinolite, sphene, and opaque grains. Although an overseas source cannot be definitely ruled out, the above minerals, as well as their relative proportions, are consistent with derivation from greywacke, a hard quartzo-feldspathic

> sandstone which makes up much of the axial ranges in both the North and South Islands [of New Zealand]. In my opinion, the sediment is more likely to be from the South Island; if pressed for a narrowing of this source, I would suggest somewhere east of the Southern Alps. Compacted rocks of similar mineralogical composition are widespread, not only among the younger sedimentary beds of southern Marlborough, Canterbury, and North Otago, but similar sediment sorted by stream and wind action, occurs widely in the beds of the large rivers in the eastern part of the island. In conclusion, judging from the general appearance and mineral content of the sediment, I would favour a New Zealand, probably South Island, source.

## SIZE AND SURFACE FEATURES

The external dimensions of the egg are approximately 208 x 134 mm, precision being ruled out by damage at the critical points of measurement. Known moa eggs are 120-240 mm long by 91-178 mm wide (Gill 2000), so B4016 is within the known size-range for moas. It is large enough to have belonged to one of the medium- to large-sized species of moas.

In shape the egg is "long oval" (Campbell & Lack 1985), that is, almost elliptical but with one end slightly blunter than the other. The ratio of length to width (1.55) is slightly higher than for other moa eggs (1.25-1.49; see table 1 of Gill 2000).

The "upper" outer surfaces of the egg, including the fragments that had collapsed and been subsequently buried by sediment, are extremely weathered. The shell in places has eroded away to a paper-thin layer (see Fig. 3 and edge of shell exposed in Fig. 2). This part of the egg had the greatest exposure to weathering, and must have become weathered before the parts collapsed inside the egg.

The "lower" outer surfaces (Fig. 1) vary in degree of weathering, and must have been shielded by sediment for much of the time. The surfaces of the least weathered areas clearly display slit-like pore openings. These are a feature of large moa eggs (see, for example, the description of such pores by Archey (1931) from the surface of thick eggshell fragments from Doubtless Bay, Northland).

Shell thickness is measurable only on fragments exposed at the edge of the large hole. All these fragments are weathered but the least damaged piece is at least 1.5 mm thick. Moa eggshell is 0.50-1.78 mm thick (Gill 2000), so B4016 is of a thickness consistent with a thick-shelled moa egg, as expected from its size.

## DISCUSSION

The possibility that the unlocalised egg B4016 belongs to any of the living ratites is ruled out by overall dimensions, surface texture and shell thickness. For example, the egg is too small and thin-shelled to be ostrich (*Struthio*), too large and thick-shelled to be kiwi (*Apteryx*), while emus (*Dromaius*) and cassowaries (*Casuarius*) have eggs with a characteristic rough surface.

Less easy to eliminate are the fossil eggs of extinct ratites, or other large birds, from Australia, Madagascar and elsewhere. However, much evidence points to the egg being from New Zealand. The characteristics of the sediment agree with a New Zealand source, and overall dimensions, the kind of surface pores, and shell thickness, are typical of the condition in moas. We conclude that B4016 is probably the egg of a medium- to large-sized moa from the eastern South Island of New Zealand. Of the 18 moa eggs listed in table 1 of Gill (2000), all but four are from the eastern South Island, including all eggs 160 mm long or longer.

C.T. scans of the egg before treatment were a useful tool in revealing the buried eggshell fragments and indicating their exact position. This allowed the removal of sediment to proceed with confidence and precision. C.T. scanning was chosen in preference to conventional X-ray studies because the radiographer advised it would provide superior spatial and contrast resolution.

Careful consideration was given to the consolidant used on the small area of sediment requiring treatment. Three consolidants were tested on samples of removed sediment: 5% w/v Paraloid B72 in toluene, 20% AYAA:AYAC w/v polyvinyl acetate resin 50:50 in toluene, and 2% w/v methyl cellulose in distilled water. Methyl cellulose was chosen because it least altered the colour of the sediment. The other two consolidants penetrated well but noticeably darkened the surface colour of the sediment. Methyl cellulose could interfere with attempts at carbon-dating eggshell that it had contacted. For this reason the area in question has been sketched and noted in the egg's documentation.

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